Influence of soundscape and interior design on anxiety and perceived tranquillity of patients in a healthcare setting

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ABSTRACT

Tranquillity characterised by a pleasant but calming environment is often to be found in natural environments where man-made noise is at a low level though natural sounds can be relatively high. Numerous studies have shown a link between such restorative environments and hospital recovery rates, stress reduction, longevity, pain relief and even how the brain processes auditory signals. In hospitals and primary care facilities there is a need to improve patient waiting rooms as current designs are largely based solely on medical need. There are often long waits in such spaces and patients are coping with the stress and anxiety caused by their medical condition. Attention should therefore be given to creating "restorative environment" as a component to their medical treatment. The study describes the effects of introducing natural sounds and large images of natural landscapes into a waiting room in a student health centre. Using self reported levels of anxiety and tranquillity it was possible to assess the impact of these targeted auditory and visual interventions had in affecting the quality of the patient experience.

Keywords: Soundscape, tranquillity, healthcare I-INCE Classification of Subjects Number: 63

1. INTRODUCTION

Tranquil spaces are often natural environments where man-made sounds are not dominant. Past research has shown that such environments improve hospital recovery rates, reduce stress, improve longevity, reduce pain and can affect how the brain processes auditory signals (1, 2, 3, 4, 5, 6). A useful and comprehensive overview of this area of research has been provided recently (7).

Previous work on elucidating the tranquillity of environments has largely focused on prediction and validation using the Tranquillity Rating Prediction Tool, TRAPT (8,9,10,11). This prediction method includes two important factors: the level of man-made noise and the percentage of natural and contextual features in the visual scene. The percentage of natural features in the landscape includes vegetation, water and geological features e.g. exposed rock outcrops. Contextual features include listed buildings, religious and historic buildings, landmarks, monuments and elements of the landscape, such as traditional farm buildings, that directly contribute to the visual context of the natural environment. Based on these factors TRAPT allows the prediction of the tranquillity of a place on a 0 to 10 scale. It is proposed to extend the model to inform the design of interior spaces and especially in health care centres where it is important to reduce stress to facilitate better mood, well being and outcomes of treatment. The method proposed involves intervention research where changes are made in a live setting and evaluations are obtained from users of the facility. Note that the approach adopted here departs from normal architectural practice in that the proposed study to inform design of restorative spaces is evidence based and certainly does not try to capture the latest trends of fashionable design.

Among other facilities in hospitals and primary care facilities there is a need to improve patient waiting rooms as current designs are largely based solely on medical need. From previous experience there are often long waits in such spaces and patients are coping with the stress and anxiety caused by their medical condition. Attention should therefore be given to creating "restorative environment" as a component to their medical treatment. All too often a lack of understanding of the influence of interior

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space on well being and budget constraints have led to the adoption of "hard" architect consisting of plain walls and ceilings, little or no wall art, no greenery or flowers and little consideration of the view from the windows, if incorporated. Further the acoustic environment or soundscape is often characterised by consistently high sound level due to reflections from hard surfaces from people sounds, their phones and monitoring equipment noise. Almost no consideration is given to noise reduction strategies.

Therefore it should be relatively easy to identify such areas within current designs of many primary care centres and hospitals though exceptionally some designs may already be informed by such considerations and there may be little room for improvement

2. METHOD

2.1 Study area

The Bradford Student Health Service (BSHS) off Laisteridge Lane has a waiting room that fitted reasonably well with requirements since it was necessary to treat an area which was reasonably well isolated from the rest of the facilities so that the effects of any environmental "treatments" that are applied as part of the study are not contaminated by sounds or views from outside the study area.

The treatments that was applied to the room was limited by a consideration of the needs of staff, doctors and practice manager and the budget available and the time constraints. Obviously the size and quality of the impact of any treatment will depend on the number of improving factors introduced and their scale.

Figure 1 shows a dimensioned plan of the waiting room. Seating was arranged around the edges of the room and there were 4 noticeboards where health related notices were displayed. In a prominent position a monitor screen gave patient prompts as appointments became due. The room has an ordinary shoe box shape with the exception of a reception area. The room volume is approximately 75m^3 and the average reverberation time measurement (RT60) for the room was 0.55sec. This was the average of three measurements made with B&K 2165 microphone and Nexus amplifier connected to PC running winMLS at 48kHz sampling rate. The impulse sound source was produced by bursting a balloon. This reverberation time for the waiting room was considered to be within acceptable limits for the use intended. The cushioned seats and sound absorptive ceiling would have contributed to this relatively low value.

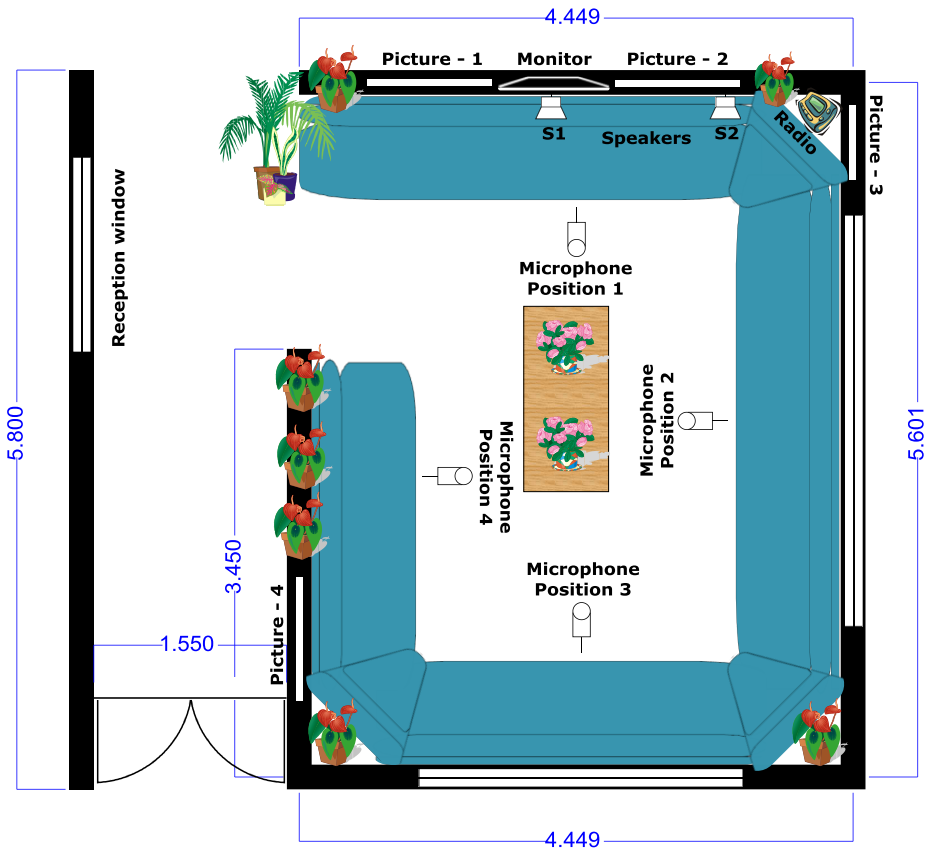

Figure 1: Plan view of waiting room

2.2 Treatment applied

The following are the adjustments that were made to the room.

Auditory factors: Reduction of disturbance from loud conversations and mobile phone use by posting prominent notices on a low table in the middle of the waiting room and reception counter indicating "Quiet zone".

Introduction of natural sounds such as water sounds. Earlier work has demonstrated that this should be as natural as possible (12) and a low volume but audible. Good examples would be recordings of a babbling brook or of waves breaking on a beach rather than high powered fountain noise or water falling in to culvert so the effect is subtle throughout the space. It was decided to use the sound of sea waves on a beach and to facilitate the choice 12 recordings taken around the coast of Britain (available from the British Library (13) were evaluated by 14 volunteers. After a practice session the participants rated the tranquility of each recording on a 0 to 10 scale of tranquillity. The recording considered on average most tranquil was the sound described as "gentle waves on sand and shingle" and was chosen for the study. The differences between sounds were highly significant (F=13.66, $p<0.0001$). This was replayed under the "adjusted" condition through speakers indicated in Figure 1 spaced to be heard throughout the waiting room. This sound replaced the radio station ("Pulse") playing popular music under the "as is" condition. The comparison of typical sound signals is presented in Figure 2 which include time histories and spectrograms. The sounds produced from the waves on sand and shingle are showing a well defined modulation with an average period of approximately 3 sec and containing higher frequency components compared to the sound of Pulse radio station.

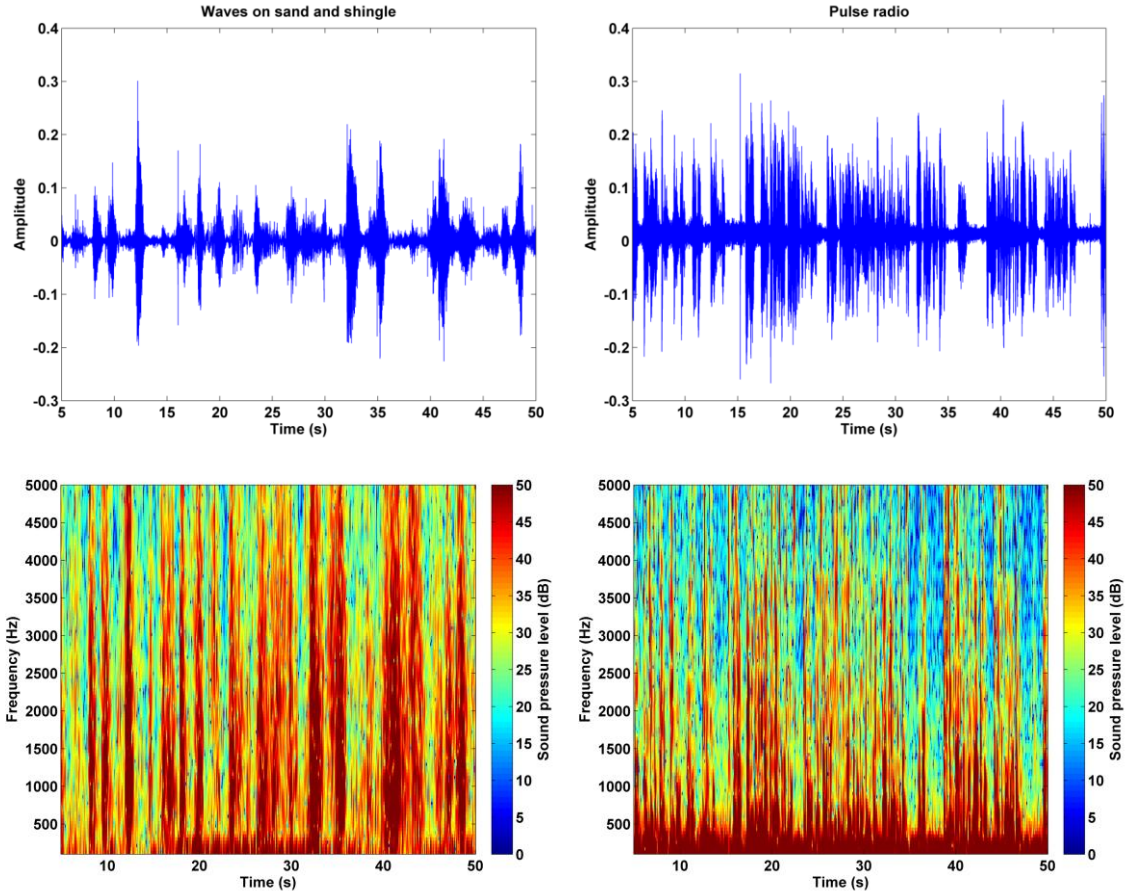

Figure 2: Comparison of the sound signals recorded at P3

Visual aspects: Changes were made to the visual aspects of the design by introducing large photographs of natural landscapes that completely covered the 4 noticeboards that previous contained health related posters and leaflets. Twenty high quality natural images of landscapes and seascapes considered tranquil were downloaded from the internet (14). A charge was made for these quality images. These were then shown to 46 volunteers who were asked to rank them in terms of tranquility. The differences between images were highly significant (F=8.90, $p<0.0001$). The 4 most highly ranked pictures were then used to prepare large high quality photographs to cover the noticeboards. Figure 3 shows three of the notice boards before and after the changes were made. Two scenes showed coastal views, one looking across a lake and the fourth showed daffodils in a park with tree blossoms.

(a) (b)

Figure 3: Comparison of the room in (a) "As is" and (b)"Adjusted" conditions

The chosen views contained no obvious buildings, infrastructure or people and containing essentially only natural elements such as of water, rock, sand and vegetation. In addition to these natural images fresh flowers (potted Chrysanthemums) were placed on ledges and the central table. Under both conditions the view through the windows was through vertical blinds and this was not altered. Some areas of grass and sky were visible as well as a small area of trees in the background.

2.3 Experimental design

The methodology was to introduce these changes sequentially and for each treatment a questionnaire survey of patients was carried out in the waiting room. The proposed design allowed two basic designs to be considered. They were:

Week 1: "as is" – this is the room as found prior to any treatments

Week 2: With visual and acoustic adjustments termed "adjusted"

Week 3: "as is" - reverse all adjustments

Two "as is" assessments were included to enable a repeated measures design to be employed.

The two basic designs comprised:

(i) Matched pairs where participants under each condition were matched on age and gender.

(ii) Repeated measures where participants recruited on their first visit to the Centre agreed to return on other days to complete the questionnaire under each condition but where in each case they were not booked for a medical appointment.

For those agreeing to return as required a £20 food voucher was on offer on successful completion.

2.4 Analysis

Using the two experimental designs we can arrive at two estimates of the benefits of the "adjusted" room over the "as is" condition.

(i) Matched pairs

Comparing anxiety levels under the two conditions during consultations we can estimate benefits by taking into account initial anxiety levels i.e. the difference between rated anxiety levels of "adjusted" over "as is". However because two separate groups of participants were involved their susceptibility to stress may have been different and so there is the possibility of sampling bias in the calculated benefit. The expectation was that this would be largely overcome by using a relatively large number of participants under each condition (81 persons)

(ii) Repeated measures

In this case the benefit can be estimated from using each participant as his or her control. Obviously the benefits when visiting to consult with doctor/nurse are not being assessed but we might reasonably assume an additive model of anxiety such that the additional stress of consultation is eliminated when calculating the difference in anxiety levels under the two conditions "as is" and "adjusted".

2.5 Questionnaire

The questionnaire was chiefly designed to measure anxiety levels and to obtain ratings of perceived tranquility.

The full details of the questionnaire will be given elsewhere but the following are the questions which will be the focus of this paper:

Does this room "help you relax", "cause you stress" or "has neither effect"?_____

Rate how anxious you are NOW by choosing a number between 0 and 10 where 0 is "least anxious" and 10 is "most anxious" ____

Estimate how anxious you were on average yesterday using the same scale:_____

Least anxious *Most anxious*

0	1	2	3	4	5	6	7	8	9	10

Then later in the questionnaire:

Rate the tranquillity of this room by choosing a number between 0 to 10 where 0 is “least tranquil ” and 10 is “most tranquil” _____

Least tranquil *Most tranquil*

0	1	2	3	4	5	6	7	8	9	10

3. RESULTS

3.1 A weighted levels

Table 1 tabulates typical A weighted levels measured under each condition for 4 positions in the waiting room shown in Figure 1.

Table 1: Sampled A weighted sound pressure levels in waiting room

Condition	P1	P2	P3	P4
As is	47.5	51.1	49.5	51.6
	48.9	52.1	49.3	44.9
	48.1	47.5	49.3	48.8
Adjusted	41.1	42.2	41.8	42.2
	42.8	41.1	42.3	40.6
	40.8	41.4	42.2	41.2

The frequency content of typical recordings under each condition opposite the speaker(s) P3 is shown in Figure 4. It can be seen that with the radio playing (“as is” condition) then the frequency content at mid frequencies is considerably higher than with the water sounds. The level averaged over 4 positions in the “as is” condition was 49.1 dB(A) while under the “adjusted condition” it was 41.6 dB(A) i.e.7.5 dB(A) lower. Average background level without radio playing or water sounds was 41.1 dB(A) i.e. slightly below that recorded for the water sounds though individual waves breaking were clearly audible throughout the room.

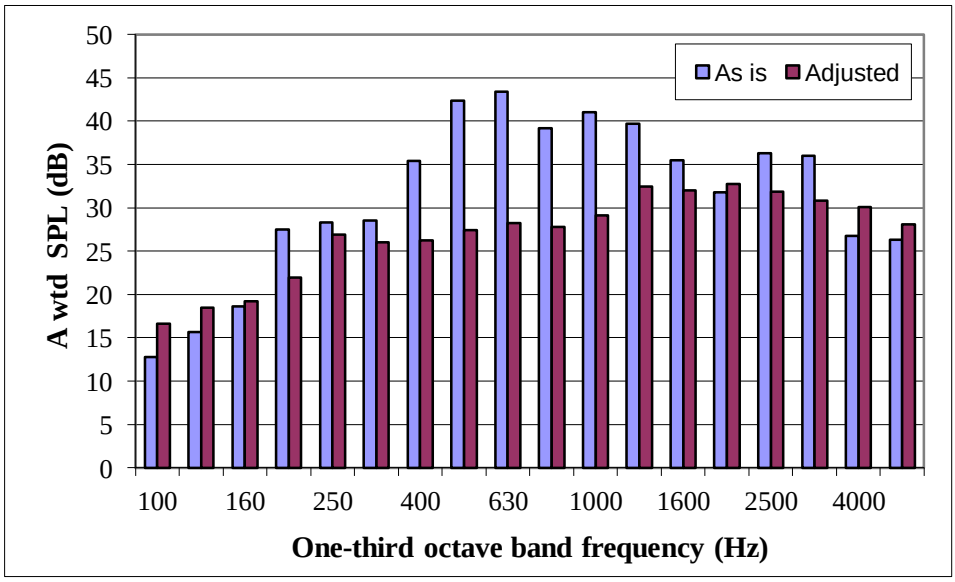

Figure 4: Typical spectra under each condition

3.2 Questionnaire results

81 questionnaires were completed under each condition. The samples under the two conditions were well matched as the average ages were 26.9 yrs and 24.8 yrs for "as is" and "adjusted" conditions respectively and the percentage of female patients was 56.3% under each condition.

The effect of the room condition had some tendencies to alter the effects on relaxation in the expected direction though the trend was not statistically significant. Figure 5 shows the frequency of responses under each condition.

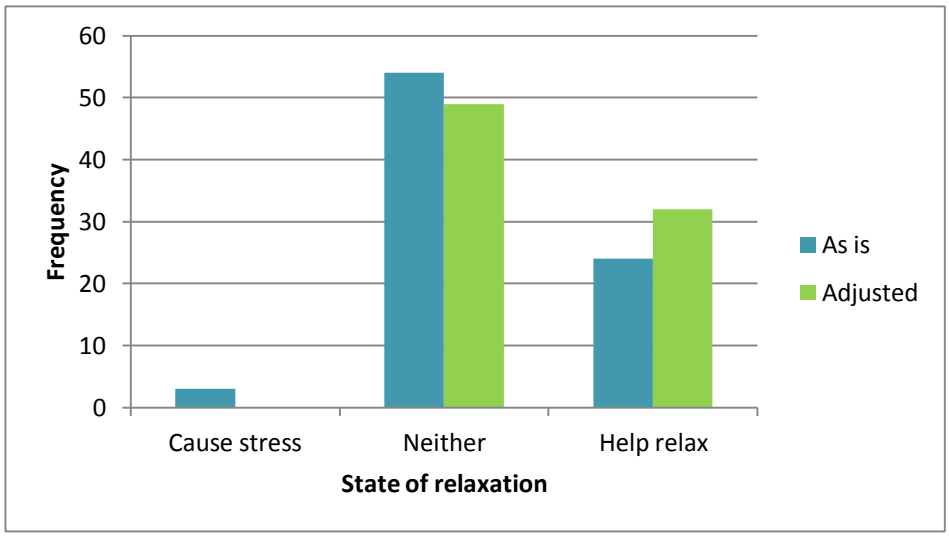

Figure 5: State of relaxation

The changes in anxiety scores under the 2 conditions are given in Figure 6 below. A negative score indicates that there is a reduction in anxiety in the surgery waiting room compared with that experienced at home. Under both conditions it can be seen that generally there are only small shifts in anxiety levels. The mean reduction in anxiety was a little larger under the adjusted condition (0.61) compared with (0.25) under the "as is" condition. Testing the mean values there was no significant difference (t=1.00, p=0.159 – one tail test)

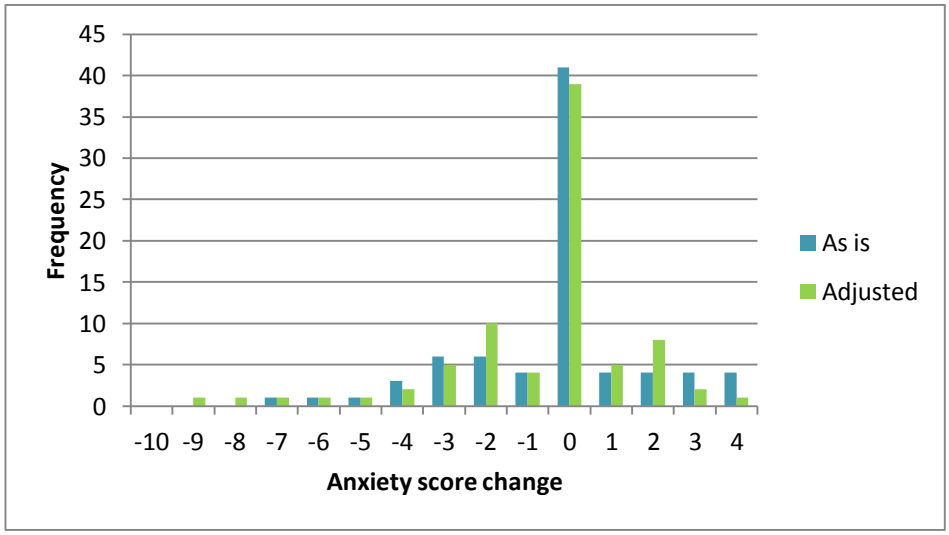

Figure 6: Change in anxiety scores under two conditions

For the seven participants who made assessments under both conditions there was a larger

difference. The mean reduction in anxiety level under the "as is" condition was -1.14 whereas under the "adjusted condition" it was -2.14. This difference was statistically significant (t=3.24, p=0.009 – 1 tail test).

For the question concerning tranquillity level it was observed that there were much larger differences. Figure 7 shows the distribution of scores.

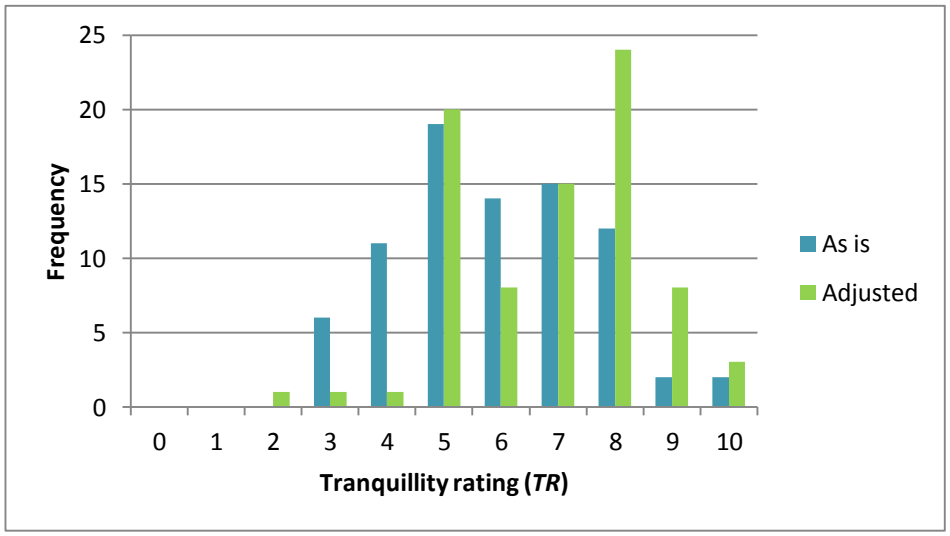

Figure 7: Tranquillity scores

The average rating under "as is" was 5.90 and this rose to 6.85 under the "adjusted" condition. This difference was statistically significant (t=3.58, p=0.0002). A noticeable feature was the large increase in high scores under the "adjusted" condition. For example the percentage of scores >7 rose from 19.8% to 43.2% and a corresponding reduction in low scores (<5) from 21.0% to 3.7%.

Again for the seven participants who made assessments under both conditions the differences were greater. Under the "as is" condition the mean score was 5.57 and under the "adjusted" it was 8.86. This is much higher than 6.85 recorded for the matched sample survey. The difference was statistically significant (t=3.16, p=0.0098)

4. DISCUSSION AND CONCLUSIONS

The results indicate that the adjusted room has had a number of effects on anxiety levels and rated tranquillity. Among the most positive effects was the rise in the average rating of tranquility from an average score of 5.9 to 6.9. There was also a marked increase in the percentage of scores >7 which rose from 20% to 43%. There was a tendency for the reduction in anxiety scores to be greater in the adjusted room. For the paired comparison groups the difference was significant. The impact on state of relaxation was not significant though there was a tendency for more participants to say they were more relaxed in the adjusted room. It should be noted that music in the "as is" condition may have been problematic because of the wide range in personal tastes in different styles. Noticeboards containing medical leaflets may also pose a problem by focusing attention on real or imagined illnesses. However, a balance needs to be struck between the need to inform patients and the need to create a restorative environment where anxiety levels are as low as possible in the circumstances

It is concluded that the changes were beneficial but not necessarily optimal and further attention to the soundscape may be required.

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